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ATTEMPTS AT A QUANTITATIVE ESTIMATE BY TRAWL SAMPLING OF DISTRIBUTION OF POSTLARVAL AND JUVENILE NOTOTHENIOIDS (PISCES, PERCIFORMES) IN RELATION TO ENVIRONMENTAL CONDITIONS IN THE ANTARCTIC PENINSULA REGION DURING SIBEX 1983–84

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Abstract: During the SIBEX 1983–84 programme, an attempt was made at a quantitative estimate of the distribution of postlarval and juvenile fish north of the South Shetland Islands and the Palmer Archipelago, and in the Bransfield Straits by means of a 368-mesh sampling trawl, designed especially for this project. A total of 14 fish species at the postlarval and juvenile stages was found in the catches. The greatest abundance up to 928 individuals per hour of fishing was recorded within shelf waters of the Antarctic Peninsula. Postlarval and juvenile *Pleuragramma antarcticum* was the most common and most abundant species there. Relations between fish abundance and environment were observed in the area studied. A decrease in the abundance of juvenile Nototheniidae and Channichthyidae accompanied an increase in depth to the bottom. The abundant occurrence of *Pleuragramma* seemed to be influenced by the temperature and salinity of water.

1. Introduction

The knowledge about juvenile Antarctic ichthyofauna in the pelagic phase of its life is still insufficient to understand the mechanisms govering its distribution and migrations, to determine the factors influencing its individual development and survival rate, as well as to establish the interrelations between juvenile fish and the pelagic ecosystem of the Antarctic. More extensive and thorough investigations of the problem were commenced at the end of the 1970's (REMBISZEWSKI *et al.*, 1978; KOMPOWSKI, 1980a, b; KOCK, 1982; ŚLÓSARCZYK, 1983a). The FIBEX programme was the first attempt at a presentation of information concerning the distribution and abundance of postlarval and juvenile fish to the background of hydrological conditions prevailing in the areas of study (KELLERMANN and KOCK, 1984; KELLERMANN and ŚLÓSARCZYK, 1984). In SIBEX 1983–84 a programme of ichthyological investigations of the FIBEX expedition was repeated by the R. V. PROFESSOR SIEDLECKI; at the same time, a new small midwater trawl designed especially for these investigations, was used to catch juvenile fish (BIOMASS, 1982). Preliminary report on this programme by ŚLÓSARCZYK and CIELNIASZEK (1985) is below revised and supplemented.

2. Materials and Methods

In the research programme of the first stage of SIBEX, among many other tasks, a new sampling trawl was tested on the R. V. Professor Siedlecki. The design of the trawl and its rigging is presented in Fig. 1. After first trials, the codend of the prototype 368-mesh trawl was reduced by half and the fine-meshed inset with a bar length

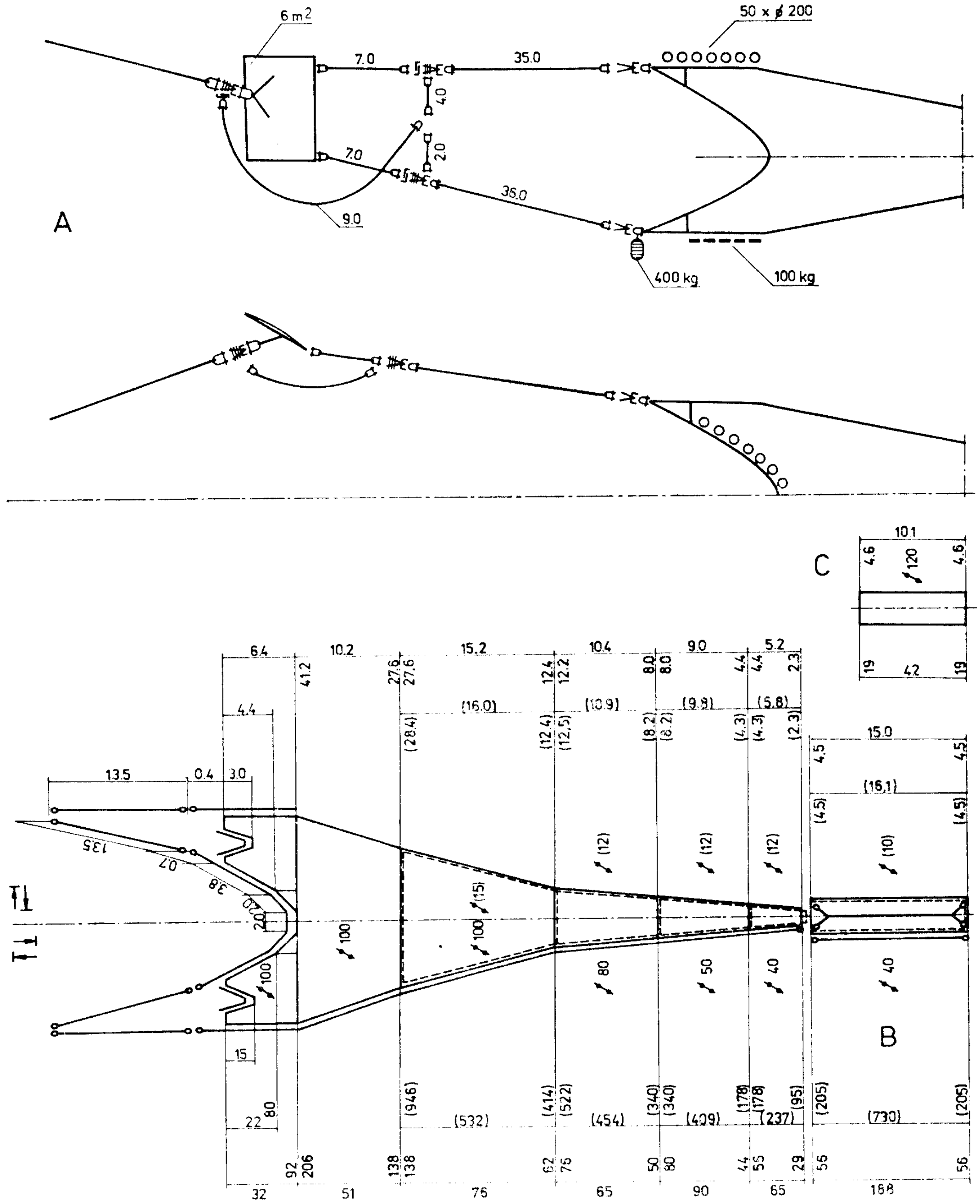

Fig. 1. General layout plan of the 368-mesh midwater sampling trawl (MST 16/41×4) designed by the Sea Fisheries Institute in Gdynia for sampling juvenile fish in SIBEX (redrawn from unpublished working plans after Moderhak *and* Krępa*). A: gear rigging, B: two-panel codend, C: outer covering of codend.*

of 4.5 mm was replaced by another inset with a bar length of 10 mm. The finer inset, whose mesh dimensions were similar to those of nets used commonly in gear for catching micronekton (RMT 8–4.5 mm, IKMWT–5–6 mm, Koc-A–5.6 mm, KYMT–3.4 mm) did not ensure good filtration during sampling the dense krill concentration. After these alterations the trawl operated well. Approximate vertical and horizontal opening of the trawl was 9 and 14 m, respectively, at a mean speed of trawling of 3 kn.

Between December 21, 1983 and January 8, 1984, within the SIBEX programme, 27 hauls with the new sampling trawl were made from the R. V. PROFESSOR SIEDLECKI (Fig. 2). Fourteen hauls were made at pre-selected stations; haul duration was usually 30 min and 3–5 depth levels were sampled: 10–15, 25–30, 50–55, 70–75 and 95–110 m. Because of the expected short duration of investigations these stations were mostly established on the shelf and continental slope of the investigated area since it was assumed that outside this zone, juvenile fish occur rarely (ŚLÓSARCZYK and REMBISZEWSKI, 1982; KELLERMANN and ŚLÓSARCZYK, 1984). The remaining hauls were made in order to determine the presence of fish in the vicinity of krill or salp patches recorded on the echosounder.

At the end of SIBEX (January 4–7, 1984), during exploratory fishing for krill, an additional observations were made on the occurrence of juvenile ichthyofauna within krill concentration north of Elephant Island, on the traditional krill fishing ground. The investigation covered 20 halus (Fig. 3) made mainly at the depths from 20 to 130 m.

The whole catch or a random sample taken from it (usually 40–50 kg, when the numbers of krill were large) was sorted out, then weighed or counted. To determine abundance of fish, two measures were used: (1) number of specimens caught in 1 hour fished (N/hf), and additionally (2) number of specimens in 100 kg of krill catch, when fish were caught together with krill. For further investigations, fish were preserved in

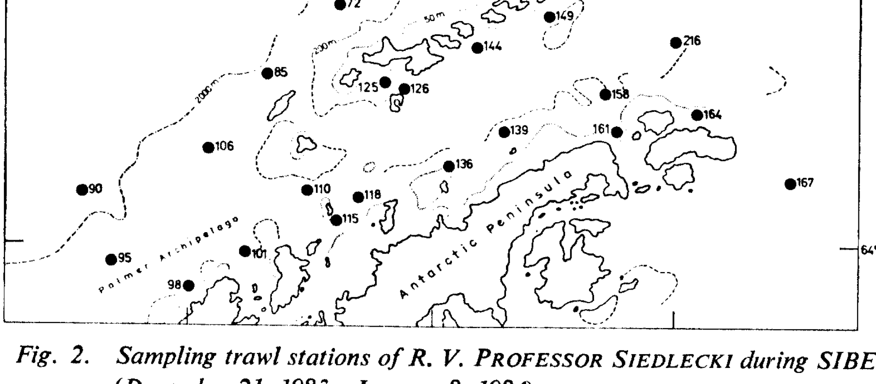

Fig. 2. Sampling trawl stations of R. V. PROFESSOR SIEDLECKI during SIBEX (December 21, 1983 – January 8, 1984).

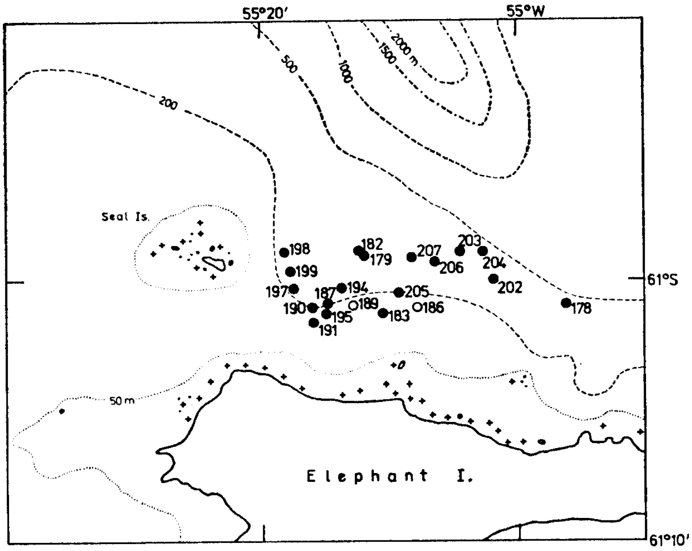

Fig. 3. Trawl stations of R. V. PROFESSOR SIEDLECKI during exploratory fishing of krill (January 4–7, 1984).

4% formaldehyde solution buffered with borax or in alcohol. Standard length (SL) of preserved specimens was measured to the nearest millimetre below. Stomach contents of the most abundant species were analysed qualitatively.

Relations observed between juvenile ichthyofauna and the environment characterized by a higher correlation coefficient (at a significance level of 0.05) then the critical value taken from Wallace-Snedecor tables, were shown graphically as data points and regression curves with the best fit. The results are based on limited data and should therefore be regarded as preliminary.

3. Results

Species composition of total trawl catches of SIBEX programme is presented in Table 1. The data contained in this table shuold not be treated in the same way as the results of quantitative macrozooplankton catches by means of Bongo or RMT nets because of relatively large mesh size in the belly and codend of the trawl. However, they could supply some information about pelagic fauna, among which postlarval and juvenile stages of fish lived and developed. In majority of hauls fish were taken together with krill (*Euphausia superba*) or salpae (*Salpa thompsoni*). In individual cases a larger share of other macroplankton (Scyphomedusae, Hydromedusae and Siphonophora) was observed. Similar catch composition was found at the krill fishing ground north of the Elephant Island.

As shown in Table 1, besides fish fry, single adult fishes were also found in the catches. Within a shallow shelf of the Antarctic Peninsula, three species were observed: *Notothenia gibberifrons* (Nototheniidae), *Gymnodraco acuticeps* (Bathydraconidae), and *Chionodraco rastrospinosus* (Channichthyidae). North of the King George Island, besides *N. gibberifrons* and *Chionodraco*, two other channichthyids occurred in the catches: *Champsocephalus gunnari* and *Neopagetopsis ionah*. Near the Elephant Island, apart

Table 1. Sampling data and composition of catches (percent by weight) with the 368-mesh midwater trawly by R. V. PROFESSOR SDIELECKI during SIBEX (December 21, 1983 – January 8, 1984).

Region	Depth range (m)	Haul No.[1]	Sampling depths (m)	Day/night-time[2]	Catch (kg per 1 hour)	Crustacea	Euphausiidae	*Euphausia superba*	*Thysanoessa macrura*	Gammaridae	Hiperiidae	Thaliacea	Salpida	*Salpa thompsoni*	Scyphozoa	Scyphomedusae	Hydrozoa	Hydromedusae	Siphonophora	*Diphyes antarctica*	Cephalopoda	Brachioteuthiidae	Pisces[3]	Nototheniidae	Nototheniidae juv.	Channichthyidae	Channichthyidae juv.	Bathydraconidae	Myctophidae	Paralepididae juv.
South Shetland Is. (shelf)	191–690 (875)	54	5–78	L	3000.0			99.9						x[4]																
		66	60–103	L	110.8			97.1		+[5]				x										2.4	x	0.5	x			
		69	15–38	D	3272.7			99.8						0.2																
		85	5–58	L	4000.0			99.5			+			0.5											+					
		106	30–58	L	6000.0			100.0																	+					
		125	10–38	L	300.0			99.3						0.7											+		+			
		126 b	20–98	L	540.0			99.6						0.4											x		x			
		144 b	10–108	L	10.2			0.9						97.7		+				+					0.1		x		1.3	
		212	5–78	L	16000.0			99.9						0.1													+			
South Shetland Is. (cont. slope)	1875–3100	57 b	4–24	N	200.0			0.1						99.9																
		72 b	15–64	L	50.0			80.0						20.0																
		90 b	55–63	L	60.0									100.0															x	
		149	80–128	L	327.3			93.7						6.2											+				x	
Antarctic Peninsula (shelf)	91–602	95	55–83	L	900.0			99.9	+					x															0.1	
		98	20–88	L	1200.0			99.9						x											x	x	x		+	
		101 b	8–108	L	300.0			98.5	+		+			1.5											x		x			
		110 b	10–120	L	1.0									99.1											0.4		0.5			
		115	35–48	L	267.0			98.9						1.1				x				+			x		x			
		118 b	9–58	L	60.0			94.6	+					5.3						x					x		x		+	
		136 b	10–103	L	2.3									+						+				49.6	49.8		0.6			x
		139 b	10–108	L	9.9									71.1		20.1				1.1				5.8	1.9					
		158 b	10–78	D	22.9			61.3						38.5											0.2		x			
		161	90–118	L	825.0			55.5						44.3						0.2					x		+	x		
		164 b	10–113	L	0.5											99.2		0.6		+					0.2					
		167 b	6–71	D	3.0			13.5						0.1				0.2		x					85.3			0.8		
		175	30–115	L	428.6			93.4						6.6											x		+			
		216 b	12–106	L	40.0			0.6						99.3													0.1			

[1] Haul type b: blind haul; remaining are identification hauls.
[2] L: daylight, D: dawn and dusk, N: night.
[3] Juvenile notothenioids listed in Tables 2 and 3, others: in text.
[4] x: abundance less than 0.1%.
[5] +: out of sample (abundance not estimated).

from *N. gibberifrons*, two more species appeared: *Notothenia corriceps* (Nototheniidae) and *Chaenocephalus aceratus* (Channichthyidae). Over the zone of a shelf or continental slope, myctophids were found: *Electrona carlsbergi, E. antarctica, Gymnoscopelus nicholsi, Protomyctophum bolini* and *Krefftichthys anderssoni.* Among fish outside the scope of this paper, it is worth mentioning postlarval *Notolepis coatsi* (Paralepididae, Table 1) found at one site within the shelf of the Antarctic Peninsula.

In the 27 hauls made during SIBEX, 21 contained postlarval (definition by Russell, 1976) or juvenile fish (Table 1). A total of 12 fish species at early developmental stages was found in the catches (Table 2). The abundance of fish was particularly high (up to 928 individuals per hour of fishing) in the shelf waters of the Antarctic

Table 2. Abundance of postlarval and juvenile fish (number per 1 hour of trawling) in the Antarctic Peninsula region during SIBEX (December 21, 1983 - January 8, 1984).

Region	Haul No.	Nototheniidae	*Pleuragramma antarcticum*	*Trematomus bernacchii*	*Trematomus newnesi*	*Trematomus hansoni*	*Dissostichus mawsoni*	Channichthyidae	*Chionodraco rastrospinosus*	*Chaenodraco wilsoni*	*Cryodraco antarcticus*	*Chaenocephalus aceratus*	*Neopagetopsis ionah*	*Pagetopsis macropterus*	*Pseudochaenichthys georgianus*	Total
South Shetland Is. (shelf)	54				61.7											61.7
	66		4.9							+(1)	4.9		14.7			24.5
	69															
	85						+									
	106			+												
	125															
	126				11.9				11.9	47.4	+					71.2
	144		6.0	2.0	2.0									2.0		12.0
	212									+						
South Shetland Is. (cont. slope)	57															
	72															
	90															
	149			+												
Antarctic Peninsula (shelf)	95															
	98			24.6					24.6	+					+	49.2
	101			11.3						22.5						33.8
	110			6.0	2.0					4.0	2.0					14.0
	115			10.6					+		10.6	21.1		10.6		52.9
	118		4.9		12.2				12.2	2.5	7.4	2.5		+		41.7
	136		898.3						13.9		1.9	3.7		8.4		926.2
	139		152.0													152.0
	158		81.1		1.8						1.8					84.7
	161		19.4			+								+		19.4
	164		2.0													2.0
	167		450.6			15.4										466.0
	175		19.7								+					19.7
	216								8.0	12.0	14.0					34.0

(1) Out of sample (abundance not estimated).

Peninsula (Table 2, Fig. 4). The most abundant and most often encountered was *Pleuragramma antarcticum* at postlarval and juvenile stages (50–113 mm, Fig. 5). Postlarval channichthyids, *Cryodraco antarcticus* and *Chaenodraco wilsoni*, were also often observed but not in great numbers.

The occurrence of 11 fish species in postlarval and juvenile stages was noted during exploratory fishing for krill near the Elephant Island. The most frequent and most

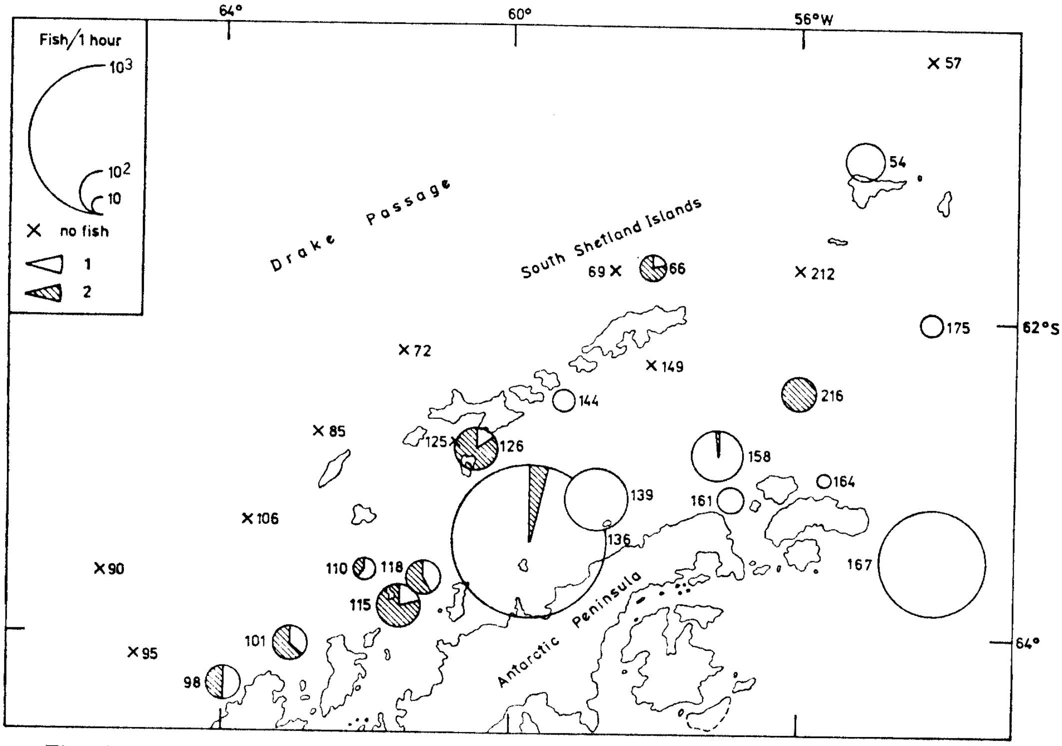

Fig. 4. Distributions and abundance (N/hf, number of specimens per hour of fishing) of juvenile Nototheniidae (1) and Channichthyidae (2) in the Antarctic Peninsula region during SIBEX (December 21, 1983 – January 8, 1984).

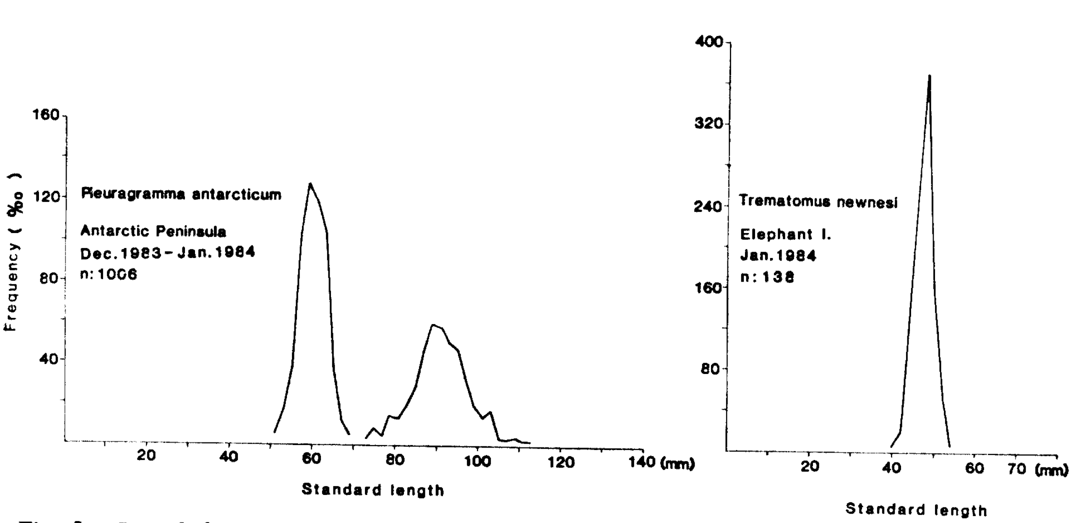

Fig. 5. Length frequency distribution of Pleuragramma antarcticum *and* Trematomus newnesi.

abundant were postlarval channichthyids: *Chaenocephalus aceratus* (22–59 mm, Fig. 6), *Cryodraco antarcticus* (38–80 mm, Fig. 6) and *Chionodraco rastrospinosus* (26–47 mm). Nototheniids were represented mainly by *Trematomus newnesi* (40–54 mm, Fig. 5).

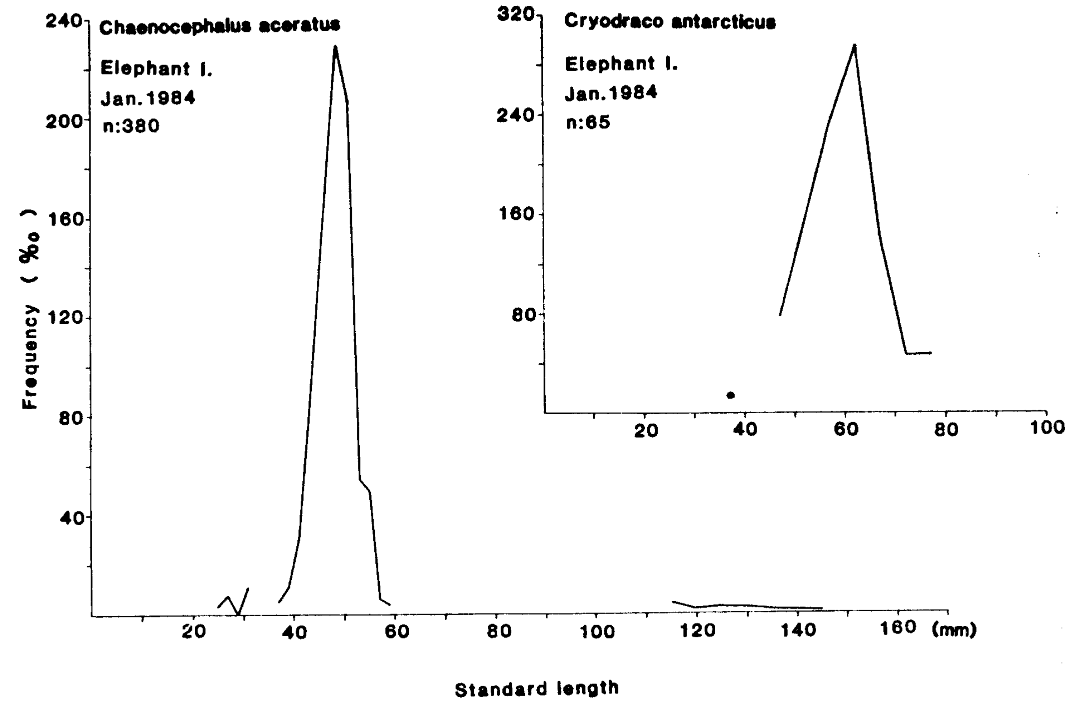

Fig. 6. Length frequency distribution of Chanenocephalus aceratus *and* Cryodraco antracticus.

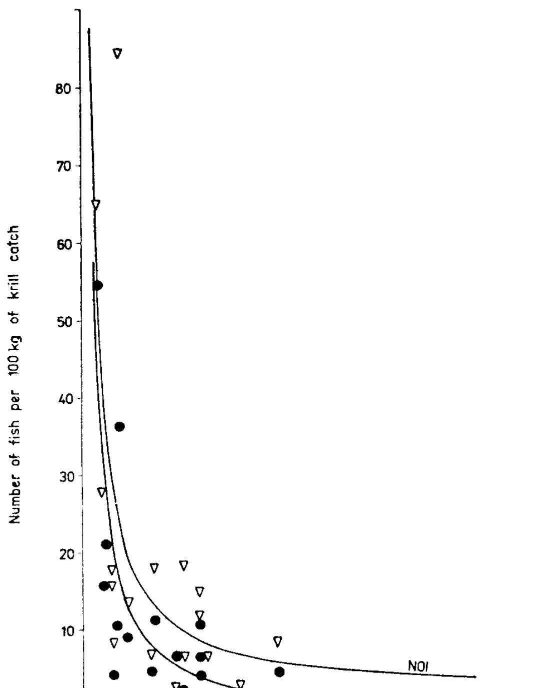

Fig. 7. Relations between the number of postlarval and juvenile Chaenocephalus aceratus *(C.A. ●) and all Nototheniodei (NOI, ▽) captured in 100 kg of krill, and the krill catch per effort in the Antarctic Peninsula region (December 21, 1983–January 8, 1984).*

Table 3. *Number of postlarval and juvenile fish captured in krill hauls (number per 100 kg krill catch) in the Antarctic Peninsula region (December 21, 1983 – January 8, 1984).*

Cruise leg	Region	Haul No.(1)	Yield of krill (kg per 1 hour)	Nototheniidae	*Pleuragramma antarcticum*	*Trematomus bernacchii*	*Trematomus newnesi*	*Trematomus scotti*	*Trematomus hansoni*	*Dissostichus mawsoni*	Channichthyidae	*Chionodraco rastrospinosus*	*Chaenodraco wilsoni*	*Cryodraco antarcticus*	*Chaenocephalus aceratus*	*Neopagetopsis ionah*	*Pagetopsis macropterus*	*Pseudochaenichthys georginanus*	Bathydraconidae	*Parachaenichthys charcoti*	Total fish captured (per 100kg of krill)
SIBEX (21 December – 3 and 8 January)	South Shetland Islands	54	2999.7				2.1														2.1
		66	107.5		4.6								+(2)	4.6		13.7					22.9
		69	3267.5																		
		72	40.0																		
		85	3982.0							+											
		106	6000.0			+															
		125	298.0		+									+							
		126	538.1				2.2					2.2	8.8	+							13.2
		149	306.8			+															
		212	15985.6										+								
	Antarctic Peninsula	95	899.2																		
		98	1199.5		+	2.1						2.1	+					+			4.2
		101	295.5			3.8							7.6								11.4
		115	264.1			4.0						+		4.0	8.0		4.0				20.0
		118	56.8		8.6	+	21.5					21.5	4.4	13.0	4.4		+				73.4
		161	457.9		4.2				+								+				4.2
		175	400.3		4.9									+							4.9
Exploratory fishing for krill (4–7 January)	Elephant Island	178	1500.0				2.1								4.2						6.3
		179	1200.0									2.1									2.1
		182	263.0				+								15.8						15.8
		183	480.0		2.3		33.8			+		4.8		7.3	36.3					+	84.5
		186	1286.0				6.2			2.1		2.1	2.1	4.1	2.1						18.7
		187	2000.0				2.0	+		+				+	+						2.0
		189	1500.0				2.1			+			2.1	2.1	10.6	+					16.9
		190	6000.0											4.3	4.3						8.6
		191	218.0				8.4			+				2.1	54.5						65.0
		194	300.0		+		2.4			+		2.4	+	2.4	21.2					+	28.4

Table 3. Continued.

Cluise leg	Region	Haul No.(1)	Yield of krill (kg per 1 hour)	Nototheniidae	*Pleuragramma antarcticum*	*Trematomus bernacchii*	*Trematomus newnesi*	*Trematomus scotti*	*Trematomus hansoni*	*Dissostichus mawsoni*	Channichthyidae	*Chionodraco rastrospinosus*	*Chaenodraco wilsoni*	*Cryodraco antarcticus*	*Chaenocephalus aceratus*	*Neopagetopsis ionah*	*Pagetopsis macropterus*	*Pseudochaenichthys georginanus*	Bathydraconidae	*Parachaenichthys charcoti*	Total fish captured (per 100kg of krill)
Exploratory fishing for krill (4–7 January)	Elephant Island	195	400.0				+					4.2			4.3						8.5
		197	1200.0											+	6.5						6.5
		198	1500.0									+		7.5	7.5						15.0
		199	565.0				2.3					2.2		+	9.0						13.5
		202	923.0									2.3	+	2.3	11.3					2.2	18.1
		203	872.0		+								+	2.3	4.6	+					6.9
		204	429.0			+						2.6	2.6	2.6	10.4						18.2
		205	1091.0																		
		206	4615.0		+										+						
		207	4500.0											+	+						

(1) SIBEX hauls: 57, 90, 110, 136, 139, 144, 158, 164, 167, 216, are not considered as krill catches.

(2) + Out of sample (abundance not estimated).

Numbers of fish as by-catch of krill ranged from 2 to 84.5 per 100 kg of krill catch (Table 3). Fish abundance could have depended on the density of krill concentration. Numbers of postlarval and juvenile Notothenioidei captured were higher in krill hauls with the low catch rates (Fig. 7).

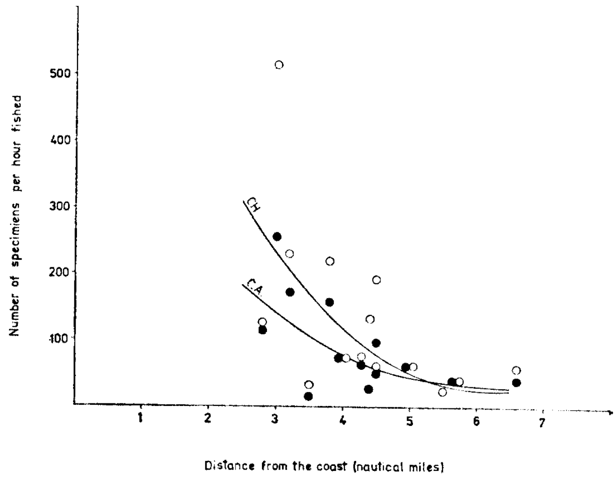

Fig. 8. Relations between the abundance (N/hf) of postlarval Chaenocephalus aceratus *(C.A. ●) and all postlarval Channichthyidae (CH. ○), and the distance of the catch sites from the coast of the Elephant Island (January 4–7, 1984).*

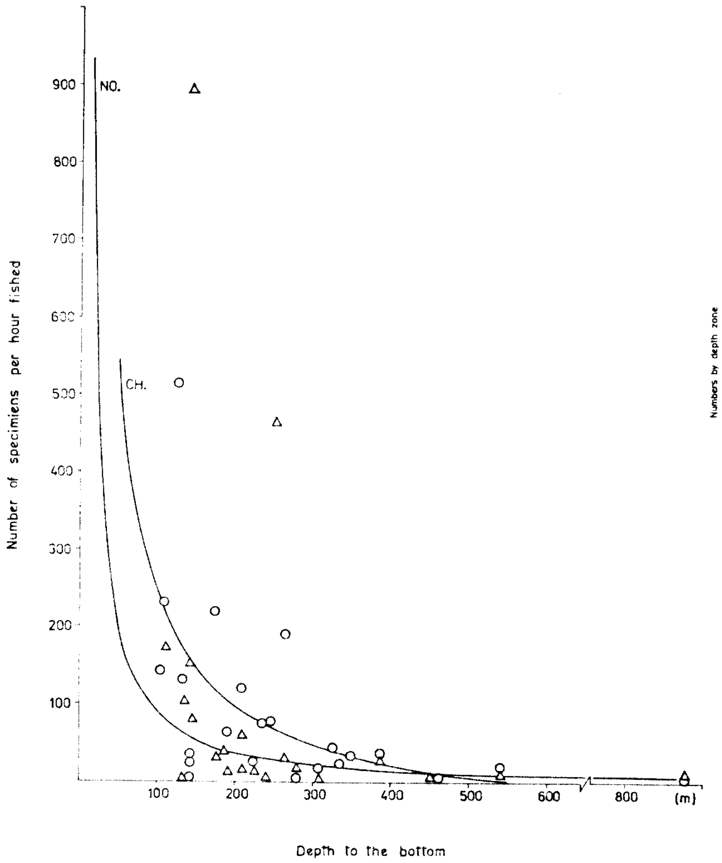

Fig. 9. Relations between the abundance (N/hf) of postlarval and juvenile Nototheniidae (NO. △) and Channichthyidae (CH. ○), and the depth to the bottom at the trawl station in the Antarctic Peninsula region (December 21, 1983 – January 8, 1984).

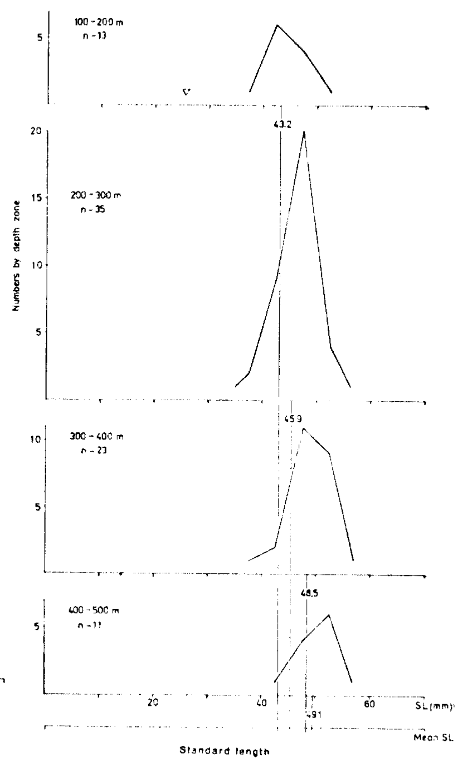

Fig. 10. Relation between the depth to the bottom and the body length of postlarval Chaenocephalus aceratus *in the Elephant Island area (January 4–7, 1984).*

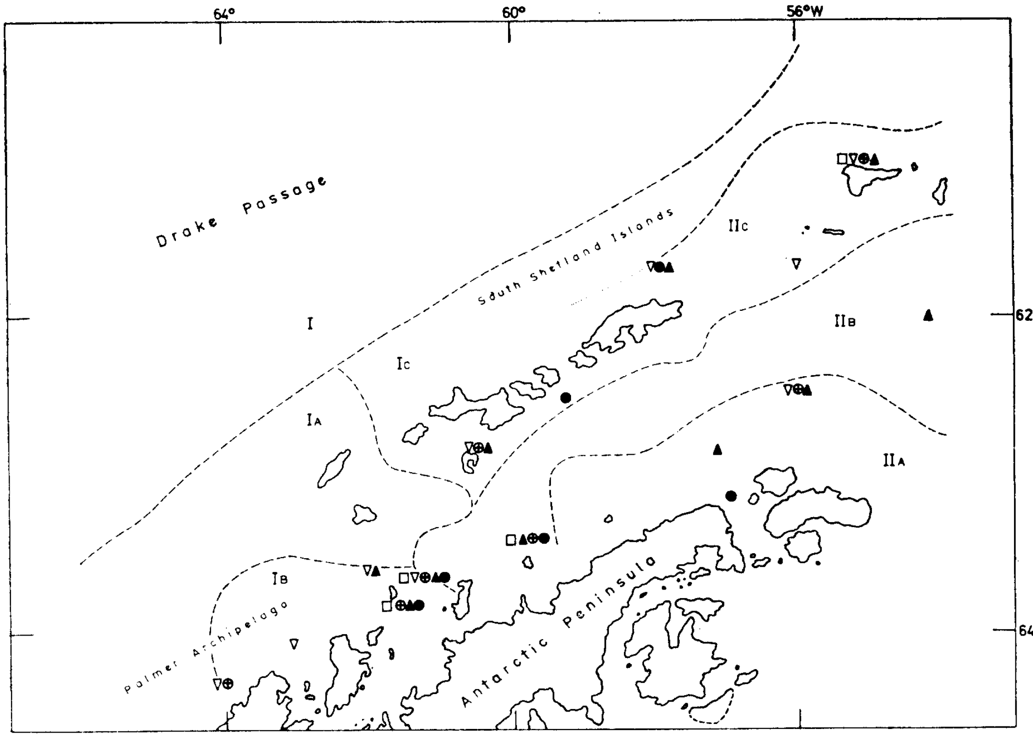

Fig. 11. Location of catches of postlarval Channichthyidae: Chaenodraco wilsoni (▽), Chionodraco rastrospinosus (⊕), Cryodraco antarcticus (▲), Pagetopsis macropterus (●), *and* Chaenocephalus aceratus (□). *Water classes distribution (December 10, 1983 – Jnauary 8, 1984) referred to the 0–200 m depth layer after* GRELOWSKI *and* TOKARCZYK *(1985).* I_{ABC}*: modified Bellingshausen Sea water,* II_{ABC}*: modified Weddell Sea water.*

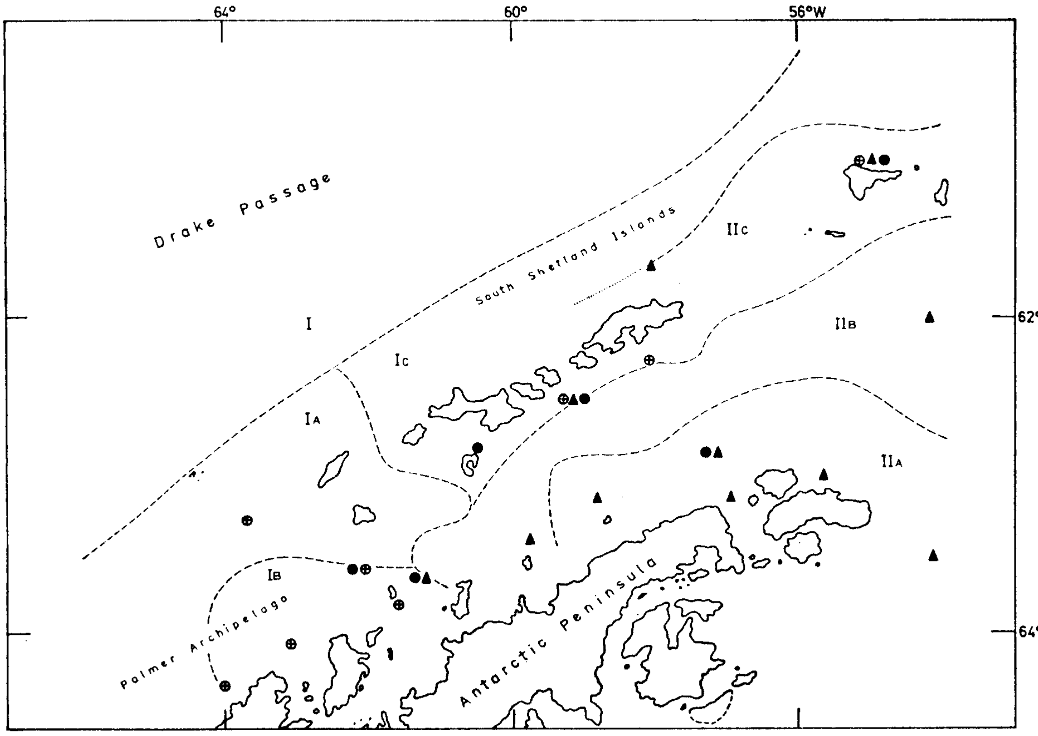

Fig. 12. Location of catches of postlarval and juvenile Pleuragramma antarcticum (▲), *postlarval* Trematomus bernacchi (⊕), *and* Trematomus newnesi (●). *Water classes distribution after* GRELOWSKI *and* TOKARCZYK *(1985).*

Fishes were associated with krill aggregations occurring in relatively shallow waters, north of the Palmer Archipelago, in single hauls near the Livingstone Island and the King Goerge Island, and north of the Elephant Island. Fishes were not found or were very rare within krill aggregations noted far from coasts of the islands. For illustration, in the zone from 2 to 6 nautical miles north of the Elephant Island, a drop

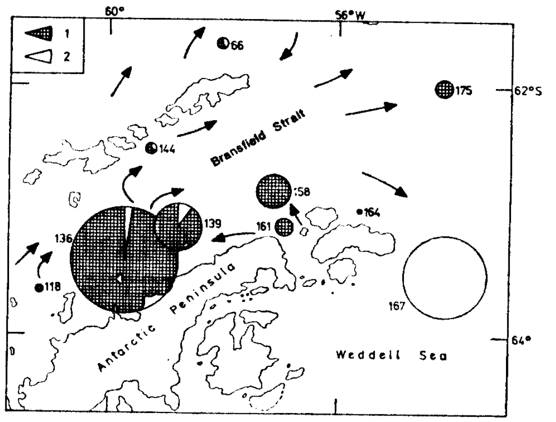

Fig. 13. Distribution and abundance (N/hf, see Fig. 4) of postlarvae (1) and juveniles (2) of Pleuragramma antarcticum *during SIBEX. Arrows indicate the direction of the relative geostrophic currnet of the 0/500 dbar level (December 10, 1983 – January 8, 1984) after* GRELOWSKI *and* TOKARCZYK *(1985).*

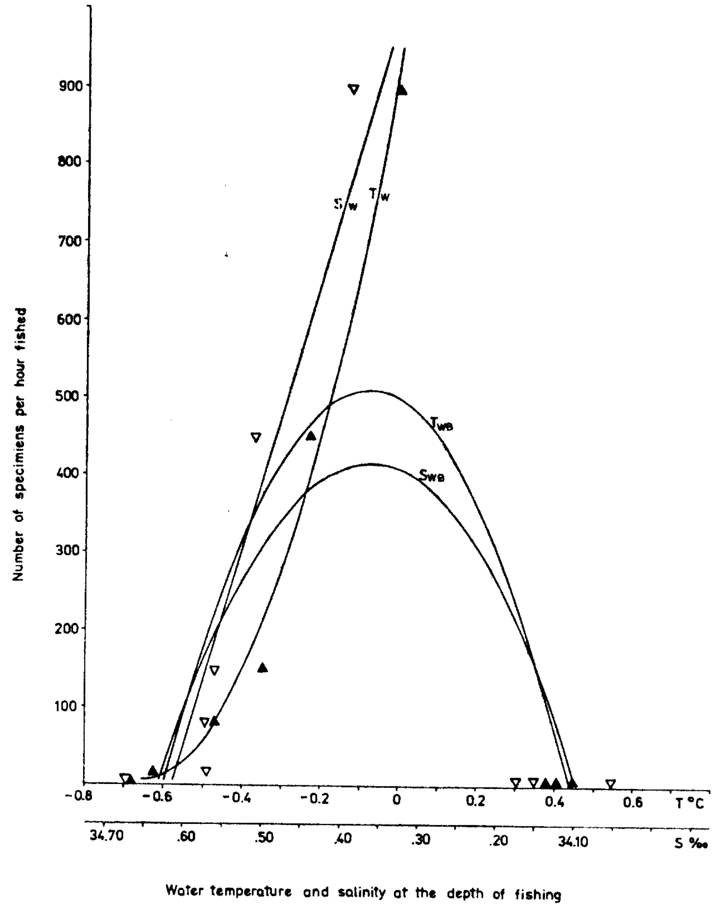

Fig. 14. Dependence of the abundance (N/hf) of Pleuragramma antarcticum *on the water temperature (T ▲) and salinity (S ▽). W: modified Weddell Sea water, WB: area influenced by the Bellingshausen Sea water included.*

in the abundance of postlarval Channichthyidae was noted when distance of the catch sites from the island increased (Fig.8). Also a decrease in the abundance of postlarval and juvenile channichthyids and nototheniids in the catches, accompanying an increase in depth was observed within the whole study area (Fig. 9). It is worth mentioning here, that in the case of *Chaenocephalus* from the krill fishing ground of the Elephant Island, an increment in the mean body length was also found, together with the increase of depth (Fig. 10).

Postlarval channichthyids were widely distributed in the area studied, without distinct preferences to water masses (Fig. 11), as well as nototheniids, with the exception of *Pleuragramma* which was clearly confined to the colder and more saline waters of the Weddell Sea origin (Fig. 12). Over the shelf of the Antarctic Peninsula and the South Shetland Islands its postlarvae were mostly found, whereas east of the Joinville Islands juveniles were abundant and adults were scarce (Fig. 13). A clear dependence of the abundance of *Pleuragramma* on the salinity and temperature of the modified Weddell Sea water was observed (Fig. 14). Additional data coming from the area influenced by the Bellingshausen Sea water allow for the presentation of approximate optimum water temperature and salinity for *Pleuragramma*; in such circumstances *Pleuragramma* was found in the Bransfield Strait in December 1983.

4. Discussion

When compared with the results of FIBEX (KOCK, 1982; ŚLÓSARCZYK and REMBISZEWSKI, 1982; KELLERMANN and KOCK, 1984; KELLERMANN and ŚLÓSARCZYK, 1984), fewer fish species were observed in the pelagic zone of the study area, and predominant species also differed. A season of investigations in 1981 and 1983–84 seems to be the main factor responsible for this. Polish investigations within the SIBEX I programme were carried out two months earlier than FIBEX and that is why certain species were still too small to get stuck in the relatively large meshes of the trawl inset while other species did not yet go beyond the coastal zone of the adjoining islands where their spawning grounds were located. Such an opinion is confirmed by the results of catches of fish larvae by means of plankton nets, made in the vicinity of trawling stations, and partly by the numerous occurrence of postlarval channichthyids in the coastal waters of the Elephant Island during 4-day long krill catches.

The abundance of postlarval and juvenile fish in krill catches was similar to that observed during FIBEX (ŚLÓSARCZYK and REMBISZEWSKI, 1982; KELLERMANN and KOCK, 1984). A more detailed comparison of fish abundance in FIBEX and SIBEX is not possible because of different gear used for sampling and quite different distribution of krill aggregations in the two seasons. However, a preliminary conclusion may be drawn from the results of the two programmes that juvenile fish off the Antarctic Peninsula do not occur in December–March in such great numbers within krill concentrations as off South Georgia (KOMPOWSKI, 1980a; ŚLÓSARCZYK, 1983b), off the Balleny Islands (ŚLÓSARCZYK, 1983a), or in the Prydz Bay (ŚLÓSARCZYK, unpublished data). Thus, in that period, off the Antarctic Peninsula, the krill fishery does not constitute such a large threat to the survival rate of juvenile fish as is the case in the above-mentioned areas which, incidentally, belong to the traditional, heavily exploited krill fishing grounds. This opinion does not refer to certain species, observed during FIBEX exclusively in the shelf zone of the Antarctic Peninsula (ŚLÓSARCZYK and REMBISZEWSKI, 1982; KELLERMANN and ŚLÓSARCZYK, 1984), for which the danger still exists. Among these, species from families Bathydraconidae and Harpagiferidae, as well as some Channichthyidae, are considered rare species or species with low fecundity (PERMITIN, 1973) and therefore thought worthy of protection.

For the reasons mentioned above, different gears used and the different krill distribution in FIBEX and SIBEX, and because of differences in the catch composition and the fish size, it is also difficult to compare changes in the fish abundance within krill aggregations in relation to their density. During FIBEX, in the period February–April, postlarval Channichthyidae, feeding intensively on krill, occurred within krill aggregations of low or medium density, which could yield catches up to 8–9 tons of krill/hf (ŚLÓSARCZYK, unpublished data). Whereas in SIBEX most of postlarval Notothenioidei was still too small to feed on krill. Postlarvae of *Pleuragramma* fed mainly on *Metridia gerlachei* (Copepoda), while juveniles almost did not feed at all in the period of SIBEX. Under these circumstances fish were frequently found outside of krill aggregations. If found in their vicinity, these were usually krill patches of low density or a dispersed group of small swarms, yielding up to 1.5 t/h (if the trawl from FIBEX were used the yield would be approximately two times greater). Postlarval *Trematomus bernacchii* in the Balleny Islands area (ŚLÓSARCZYK, 1983a) and postlarval *Patagonotothen larseni* from the shelf of South Georgia (WOLNOMIEJSKI and BOBERSKI, unpublished data) also preferred low density krill patches. Food of these species was not studied, but because of their small size (27–44 mm SL), krill even juvenile could not have constituted their main food, and a dense concentration of krill could not have been the place with other food available.

During February–March 1981, in the southern part of the Bransfield Strait, in the waters of the Weddell Sea origin, postlarval Channichthiydae were noted in great numbers, mainly *Chionodraco rastrospinosus* and *Chaenodraco wilsoni* (ŚLÓSARCZYK and REMBISZEWSKI, 1982). In SIBEX the high abundance of postlarvae was again

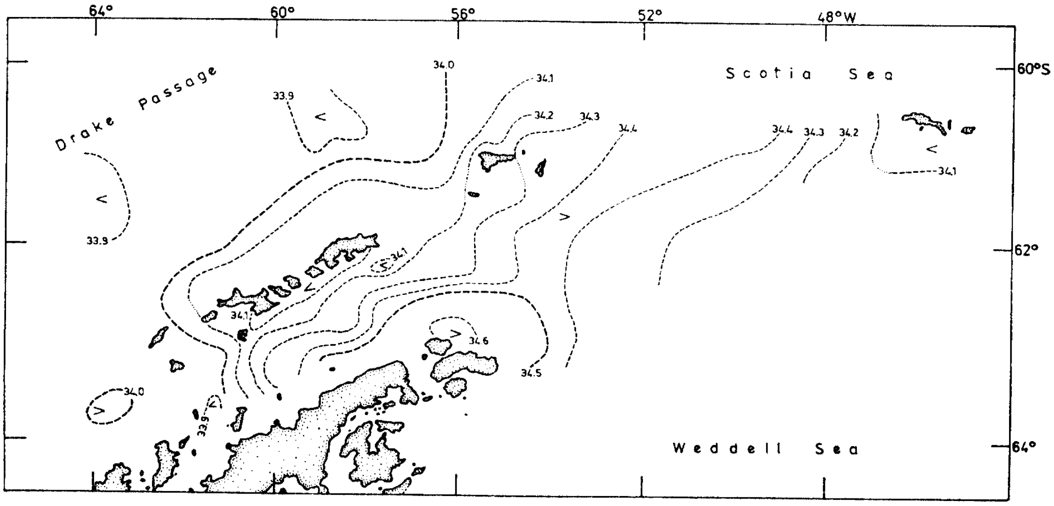

Fig. 15. Distribution of the water surface salinity (×10⁻³) in December 1983–January 1984.

observed in this area, but this time the dominant species was *Pleuragramma*. During the period of investigations, a wide stretch of the Strait was under the influence of the cold and more saline Weddell Sea water (Grelowski and Tokarczyk, 1985). To illustrate the range of this influence, a distribution in the area studied of the water surface salinity is presented in Fig. 15 (Grelowski *et al.*, unpublished data). It may be expected that before our investigations began, a strong inflow of Weddell Sea waters to the Strait had taken place and in this way *Pleuragramma* was carried there from the areas of its greatest concentrations in the south-eastern part of the Weddell Sea (Keller, 1983). Postlarval stages of *Pleuragramma*, more passive than its juveniles and adults, could have been transported deep into the Strait by the currents, reaching the vicinity of the Tower Island and the Trinity Island in the west and the South Shetland Islands in the north (Fig. 13). Further drift of postlarvae was most likely arrested by a front of warmer and less saline waters coming from the Bellingshausen Sea. The preference for waters of certain temperature and salinity may also have been the reason that *Pleuragramma* did not go beyond the frontal zone and was gradually aggregated in the south-western part of the Bransfield Strait by the inflowing Weddell Sea waters.

The distribution of juvenile ichthyofauna in the pelagic zone of Bransfield Strait and Drake Passage depends upon a large degree on the depth of the area or its distance from the land. In the FIBEX programme it was found that postlarval and juvenile Notothenioidei occur almost exclusively over the shelf area (Ślósarczyk and Rembiszewski, 1982; Kellermann and Kock, 1984). The results of similar observations in SIBEX were presented graphically in the form of a relationship between fish abundance in samples and the depth to the bottom at the site of their capture or the distance from land. Another way of presenting these observations could have been cumulative curve of the total number of fish as done by Williams (unpublished data) in FIBEX. Calculating in this way which part of fish was caught in SIBEX, let us say to a depth of 300 m, in the case of Nototheniidae we obtain 96.7% (including 79.2% of *Pleuragramma*), and for Channichthyidae–90.7%. Williams evaluates proportion of *Pleuragramma*, taken with the RMT net over the shelf of Prydz Bay down to depths of 300–400 m, at a level of 95%–Channichthyidae at about 70% down to 500 m. From the one year's sampling nearshore in the Cumberland East Bay at South Georgia, presence of early larval stage for nine species of the fish was found (Burchett *et al.*, 1983). The ranges of occurrence of larvae in the pelagic zone varied widely from April to December, according to the fish species. It is difficult to find time changes in relations observed during short SIBEX I programme. Because FIBEX is too distant to be compared, a joint analysis of SIBEX II, which lasts almost the whole summer season of 1984/85, would bring necessary information. Having more data it would be possible on their basis to determine the zones of the shelf, measured either by the distance from the land or water depth, in which in certain specified seasons, abundance and species diversity of fish larvae and juveniles are the greatest. These zones should be protected against intensive pelagic fishing operations with fine-meshed trawls, in order not to destroy fish fry and not diminish recruitment to the adult stocks heavily exploited anyway.

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References

BIOMASS (1982): Meeting of the BIOMASS Working Party on Fish Ecology, Hamburg, 20–25 September, 1982. BIOMASS Rep. Ser., **28**, 1–24.

Burchett, M. S., Sayers, P. J., North, A. W. and White, M. G. (1983): Some biological aspects of the nearshore fish populations at South Georgia. Br. Antarct. Surv. Bull., **59**, 63–74.

Grelowski, A. and Tokarczyk, R. (1985): Hydrological conditions in the Bransfield Strait and the southern Drake Passage between December 10, 1983 and January 8, 1984 (BIOMASS-SIBEX). Pol. Polar Res. (in press).

Keller, R. (1983): Contributions to the early life history of *Pleuragramma antarcticum* Boul. 1902 (Pisces, Nototheniidae) in the Weddell Sea. Meeresforschung, **30**, 10–24.

Kellermann, A. and Kock, K.-H. (1984): Postlarval and juvenile notothenioids (Pisces, Perciformes) in the Southern Scotia Sea and Northen Weddell Sea during FIBEX 1981. Meeresforschung, **30**, 82–93.

Kellermann, A. and Ślósarczyk, W. (1984): Distribution of postlarval and juvenile Notothenioidei the Atlantic sector of the Southern Ocean during FIBEX 1981. BIOMASS Rep. Ser., **36**, 1–27.

Kock, K.-H. (1982): Fische aus RMT 8-Krillschwimmschlepp-netzfangen während FIBEX 1981. Arch. Fischereiwiss., **33** (1), 97–112.

Kompowski, A. (1980a): On feeding *Champsocephalus gunnari* Lönnberg, 1905 (Pisces, Chaenichthyidea) off South Georgia and Kerguelen Islands. Acta Ichthyol. Piscatoria, **10**(1), 25–44.

Kompowski, A. (1980b): Studies on juvenile *Chaenocephalus aceratus* Lönnberg, 1906 (Pisces, Chaenichthyidae) from off South Georgia. Acta Ichthyol. Piscatoria, **10**(1), 45–53.

Permitin, Yu. Ye. (1973): Fecundity and reproduction biology of ice fish (fam. Chaenichthyidae), fish of the family Muraenolepidae and dragonfish (Bathydraconidae) of the Scotia Sea (Antarctica). J. Ichthyol., **13**, 204–215.

Rembiszewski, J. M., Krzeptowski, M. and Linkowski, T. B. (1978): Fishes (Pisces) as by-catch in fisheries of krill *Euphausia superba* Dana (Euphausiacea, Crustacea). Pol. Arch. Hydrobiol., **25**, 677–695.

Russell, F. S. (1976): The Eggs and Planktonic Stages of Brithish Marine Fishes. New York, Academic Press, 524 p.

Ślósarczyk, W. (1983a): Juvenile *Trematomus bernacchii* and *Pagothenia brachysoma* (Pisces, Nototheniidae) within krill concentrations off Balleny Islands (Antarctic). Pol. Polar Res., **4** (1–4), 57–69.

Ślósarczyk, W. (1983b): Preliminary estimation of abundance of juvenile Nototheniidae and Channichthyidae within krill swarms east of South Georgia. Acta Ichthyol. Piscatoria, **13**(1), 3–11.

Ślósarczyk, W. and Cielniaszek, Z. (1985): Postlarval and juvenile fish (Pisces, Perciformes and Myctophiformes) in the Antarctic Peninsula region during SIBEX 1983/84. Pol. Polar Res. (in press).

Ślósarczyk, W. and Rembiszewski, J. M. (1982): The occurrence of juvenile Notothenioidei (Pisces) within krill concentrations in the region of the Bransfield Strait and southern Drake Passage. Pol. Polar Res., **3** (3–4), 299–312.

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